

SECTION 03603

EPOXY COMPOUNDS FOR CONCRETE RESTORATION AND TOPPING

PART 1 - GENERAL

0.1 DESCRIPTION OF WORK

- A. Work Included: This Section specifies epoxy compounds for concrete restoration and topping for existing or new construction.

0.2 SUBMITTALS

- A. Submit certificates of compliance, from independent testing laboratories, approved by Engineer, attesting to compliance with data requirements of the Section.
- B. Submit manufacturer's application and installation instructions for products.

0.3 JOB CONDITIONS

- A. Safety: Applicators shall wear protective clothing, gloves, goggles, barrier creams and take such other precautionary measures as are recommended by manufacturer or any federal, state or municipal rule, law, or regulation having jurisdiction with special attention being directed at adequate ventilation and dissipation of noxious fumes and other byproducts generated in the mixing and application of products specified herein.

PART 2 - PRODUCTS

0.1 MATERIALS

- A. Qualification of Resin Types based on examination under requirements of ASTM C881:

Grade	Type I	Type II	Type III
1	Class A - N/A Class B - Resin Type A Class C - Resin Type A	Class A - N/A Class B - Resin Type A Class C - Resin Type A	Class A - N/A Class B - N/A Class C - Resin Type D
2	Class A - N/A Class B - Resin Type	Class A - N/A Class B - Resin Type	Class A - N/A Class B - Resin Type

	B Class C - Resin Type B	B Class C - Resin Type B	E Class C - Resin Type E
3	Class A - N/A Class B - Resin Type C Class C - Resin Type G	Class A - N/A Class B - Resin Type C Class C - Resin Type C	Class A - N/A Class B - Resin Type F Class C - Resin Type F

B. Definitions

1. Type I: For use in bonding hardened concrete and other materials to hardened concrete.
2. Type II: For use in bonding freshly mixed concrete to hardened concrete.
3. Type III: For use in bonding skid-resistant materials to concrete and as a binder in epoxy mortars and epoxy concrete.
4. Grade 1: Low viscosity (less than 2,000 cps)
5. Grade 2: Medium viscosity (2,000 - 10,000 cps)
6. Grade 3: Non-sagging consistency
7. Class A: For use below 40°F
8. Class B: For use between 40° - 60°F
9. Class C: For use above 60°F
10. N/A: Not Available

0.2 RESIN TYPE COMPOUNDS

- A.** Resin Type A Compound is a two-component, solvent free, moisture insensitive, multipurpose, epoxy resin adhesive.

1. Physical Properties:
 - a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	Neat			Mortar		
	40F	73F	90F	40F	73F	90F
4 hour	-	-	-	-	-	800
8 hour	-	10	3,200	-	400	4,100
16 hour	-	3,600	6,300	-	4,900	5,700
1 day	-	6,800	9,100	120	5,000	6,900
3 day	3,600	9,800	10,500	6,200	6,800	7,000
7 day	8,000	10,700	10,500	6,300	7,900	8,800
14 day	10,300	11,100	10,500	6,800	8,500	8,800

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28 day	12,400	11,700	10,500	7,000	8,600	8,800

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	NEAT	MORTAR (1:5)
b. Modulus of Elasticity, Psi		
28 day	3.5×10^5	8.1×10^5
c. Tensile Properties (ASTM D-638):		
14 day - Tensile Strength	8,400 psi	840 psi
Elongation at Break	4.2%	0.3%
Modulus of Elasticity	4.1×10^5 psi	7.6×10^5 psi
d. Flexural Properties (ASTM D-790):		
14 day - Flexural Strength	14,000 psi	2,200 psi
(Modulus of Rupture)	3.7×10^5 psi	9.5×10^5 psi
Tangent Modulus of Elasticity in Bending		
e. Shear Strength (ASTM D-732):		
14 day - Shear Strength	5,100 psi	2,300 psi
f. Deflection Temperature (ASTM D-648):		
14 day - Deflection Temperature	127°F	129°F
g. Bond Strength (ASTM C-882):		
Hardened concrete to hardened concrete	2,800 psi	
2 day (dry cure) - Bond Strength	2,800 psi	
14 day (moist cure) - Bond Strength		
h. Water Absorption (ASTM D-570)		
7 day - Total Water Absorption (2 hour boil)	1.1%	

- B.** Resin Type Compound B is a two-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
8 hours	-	-	100
16 hours	-	2,400	4,500
1 day	-	4,600	6,400
3 day	800	8,100	8,200
7 day	7,200	9,500	8,200
14 day	8,100	9,500	8,200
28 day	8,800	9,500	8,200

Modulus of Elasticity, psi:

28 day

4.4 X 10⁵ psi

b. Tensile Properties (ASTM D-638): 14 day - Tensile Strength Elongation at Break Modulus of Elasticity	4,800 psi 1.9% 3.2 X 10 ⁵ psi
c. Flexural Properties (ASTM D-790): 14 day - Flexural Strength (Modulus of Rupture) Tangent Modulus of Elasticity in Bending	7,400 psi 4.7 X 10 ⁵ psi
d. Shear Strength (ASTM D-732): 14 day Shear Strength	5,900 psi
e. Water Absorption (ASTM D-570): 7 day Total Water Absorption (2 hour boil)	0.7%
f. Deflection Temperature (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading= 264 psi)	121°F
g. Bond Strength (ASTM D-882): 14 day (moist cure) - Plastic concrete to Hardened	1,900 psi

Concrete Plastic Concrete to Steel	1,900 psi
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- C. Resin Type Compound C is a two-component, solvent-free, moisture insensitive, high modulus, structural epoxy paste adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
2 hour	-	-	900
4 hour	-	140	5,400
8 hour	-	6,800	8,800
16 hour	400	9,600	10,100
1 day	3,900	9,800	11,700
3 day	6,700	11,300	11,900
7 day	9,100	12,000	13,000
14 day	10,400	12,000	13,000
28 day	11,200	12,000	13,000

b. Modulus of Elasticity, psi	
28 day	8.3 X 10 ⁵
c. Tensile Properties (ASTM D-638):	
14 day - Tensile Strength	3,600 psi
Elongation at Break	0.4%
Modulus of Elasticity	7.5 X 10 ⁵ psi
d. Flexural Properties (ASTM D-790):	
14 day - Flexural Strength (Modulus of Rupture)	4,400 psi
Tangent Modulus of Elasticity in Bending	1.0 X 10 ⁵ psi
e. Shear Strength (ASTM D-732):	
14 day - Shear Strength	3,400 psi
f. Bond Strength (ASTM C-882): Hardened Concrete to Hardened Concrete	
2 day (dry cure) - Bond Strength	3,300 psi
14 day (moist cure) - Bond Strength	2,400 psi
g. Deflection Temperature (ASTM D-648):	
14 day - Deflection Temperature (fiber stress loading = 264 psi)	128°F
h. Water Absorption (ASTM D-570):	

7 day - Total Water Absorption (2 hour boil)	0.79%
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D. Resin Type Compound D is a two-component, solvent-free, moisture-insensitive, epoxy resin binder.

1. Physical Properties:

a. Compressive Properties Mortar 1:6 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	500
8 hour	-	400	2,200
16 hour	20	2,100	4,600
1 day	40	2,600	4,700
3 day	1,400	4,900	5,500
7 day	3,500	5,400	6,200
14 day	4,500	6,000	6,200
28 day	4,600	6,100	6,200

b. Modulus of Elasticity, psi:	
28 days	7.6 X 10 ⁵ psi
c. Tensile Properties Mortar 1:6 (ASTM D-638):	
14 day - Tensile Strength	1,300 psi
Elongation at Break	0.2%
Modulus of Elasticity	6.6 X 10 ⁵ psi
d. Flexural Properties Mortar 1:6 (ASTM D-790):	
14 day - Flexural Strength (Modulus of Rupture)	2,300 psi
Tangent Modulus of Elasticity in Bending	1.2 X 10 ⁶ psi
e. Shear Strength Mortar 1:6 (ASTM D-732):	
14 day - Shear Strength	2,000 psi
f. Water Absorption Neat (ASTM D-570):	
7 day - Total Water Absorption (2 hour boil)	1.17%
g. Deflection Temperature Mortar 1:6 (ASTM D-648):	
14 day - Deflection Temperature (fiber stress loading=66psi)	111°F
h. Bond Strength (ASTM D-882) Hardened concrete to hardened concrete	
2 day (dry cure) - Bond Strength	1,100 psi
14 day (moist cure) - Bond Strength	1,600 psi
i. Abrasion Mortar 1:6 (Tabor Abrader):	

14 day - Weight loss, 1,000 cycles (H-22 wheel, 1,000 gm weight)	4.1 gm
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E. Resin Type Compound E is a two-component, solvent-free, moisture insensitive, epoxy resin binder.

1. Physical Properties:

a. Compressive Properties Mortar 1:5 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	100
8 hours	-	100	1,100
16 hour	-	2,700	4,300
1 day	30	3,500	5,200
3 day	600	4,600	6,000
7 day	4,200	5,400	6,200
14 day	6,200	6,000	6,200
28 day	6,300	6,100	6,200

b. Modulus of Elasticity, psi:	
28 days	7.7 X 10 ⁵ psi
c. Tensile Properties Mortar 1:5 (ASTM D-638)	
14 day - Tensile Strength	1,100 psi
Elongation at Break	0.2%
Modulus of Elasticity	5.4 X 10 ⁵ psi
d. Flexural Properties Mortar 1:5 (ASTM D-790)	
14 day - Flexural Strength (Modulus of Rupture)	2,600 psi
Tangent Modulus of Elasticity in Bending	1.1 X 10 ⁶ psi
e. Shear Strength Mortar 1:5 (ASTM D-732):	
14 day - Shear Strength	2,700 psi
f. Water Absorption Neat (ASTM D-570):	
7 day - Total Water Absorption (2 hour boil)	1.3%
g. Deflection Temperature Mortar 1:5 (ASTM D-648):	
14 day - Deflection Temperature (fiber stress loading=66 psi)	108°F

h. Bond Strength (ASTM D-882): Hardened concrete to hardened concrete	
2 day (dry cure) - Bond Strength	1,100 psi
14 day (moist cure) - Bond Strength	2,000 psi
i. Abrasion Mortar 1:5 (Taber Abrader):	
14 day - Weight loss, 1,000 cycles (H-22 wheel; 1,000 gm weight)	4.6 gm

F. Resin Type Compound F is a two-component, solvent-free, moisture insensitive, low modulus, paste-consistency, non-sagging epoxy resin binder.

1. Physical Properties.

a. Compressive Properties Mortar 1:1 (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
8 hour	-	-	3,500
16 hour	-	3,300	5,600
1 day	-	4,500	5,700
3 day	100	5,600	5,800
7 day	2,200	6,500	5,800
14 day	7,300	7,100	5,900
28 day	7,400	7,200	6,000

b. Modulus of Elasticity, psi:	
28 days	4.0 X 10 ⁵
c. Tensile Properties Mortar 1:1 (ASTM D-638):	
14 day - Tensile Strength	2,400 psi
Elongation at Break	1.0%
Modulus of Elasticity	6.1 X 10 ⁵ psi
d. Flexural Properties Mortar 1:1 (ASTM D-790)	
14 day - Flexural Strength (Modulus of Rupture)	3,900 psi
Tangent Modulus of Elasticity in Bending	6.8 X 10 ⁵ psi
e. Shear Strength Mortar 1:1 (ASTM D-732):	
14 day - Shear Strength	3,300 psi

f. Water Absorption Neat (ASTM D-570): 7 day - Total Water Absorption (2 hour boil)	0.4%
g. Deflection Temperature Mortar 1:1 (ASTM D-648): 14 day - Deflection Temperature (fiber stress loading=66 psi)	102°F
h. Bond Strength (ASTM D-882): Hardened concrete to hardened concrete 2 day (dry cure) - Bond Strength 14 day (moist cure) - Bond strength	 2,600 psi 1,700 psi

- G.** Resin Type Compound G is a two-component, solvent-free, moisture-insensitive, high modulus, high-strength structural epoxy adhesive.

1. Physical Properties:

a. Compressive Properties (ASTM D-695):

Compressive Strength, psi	40F	73F	90F
4 hour	-	-	300
8 hour	-	300	4,300
16 hour	100	7,000	6,900
1 day	1,400	7,000	6,900
3 day	7,600	9,000	8,200
7 day	9,000	9,000	8,200
14 day	9,000	9,000	8,200
28 day	9,000	9,000	8,200

b. Modulus of Elasticity, psi	
28 day	5.4 X 10 ⁵ psi
c. Tensile Properties (ASTM D-638):	
14 day - Tensile Strength	5,400
Elongation at Break	1.3%
Modulus of Elasticity	4.1 X 10 ⁵ psi
d. Flexural Properties (ASTM D-790)	
14 day - Flexural Strength (Modulus of Rupture)	6,700 psi
Tangent Modulus of Elasticity in Bending	7.5 X 10 ⁵ psi
e. Shear Strength (ASTM D-732):	
14 day - Shear Strength	3,700 psi
f. Bond Strength (ASTM D-882):	
Hardened concrete to hardened concrete:	
2 day (dry cure) - Bond Strength	3,000 psi
14 day (moist cure) - Bond Strength	2,600 psi
Hardened concrete to steel:	
2 day (dry cure) - Bond Strength	3,300 psi
14 day (moist cure) - Bond Strength	2,600 psi

PART 3 - EXECUTION

0.1 SURFACE PREPARATION

- A.** All Compounds: Substrate must be clean and sound. It may be dry or damp, but free of standing water. Remove dust, laitance, grease, curing compounds, impregnations, waxes, foreign particles, and disintegrated materials. Prepare as follows:
1. Concrete - Sandblast or use other approved mechanical means.
 2. Steel - Sandblast or white-metal finish.

0.2 MIXING

- A.** Mix components in strict accordance with manufacturer's instructions.

0.3 APPLICATIONS

- A.** Resin Type A:
1. To gravity feed cracks - Pour neat compound into vee-notched crack. Continue placement until completely filled. Seal underside of slab prior to filling if cracks reflect through.
 2. To pressure inject cracks - Use automated injection equipment or manual method. Set appropriate injection ports based on system used. Seal ports and cracks with recommended sealers. When the epoxy adhesive has cured, inject compound with steady pressure.
 3. To anchor bolts, dowels, and pins - Annular space around bolt should not exceed 1/8-in.; depth of embedment is typically 10-15 times the bolt diameter. Grout with neat compound.
 4. To seal slabs - Spread neat compound over slab. Allow penetration. Remove excess to prevent surface film. Seal interior slabs and above-grade exterior slabs only.
 5. For an epoxy mortar - Prime prepared surface with neat compound. Place prepared epoxy mortar before primer becomes tack-free. Place the epoxy mortar using trowels. Compact and level with vibrating screed or trowels. Finish with finishing trowel. Compound mortar is for interior use only.
 6. Limitations:
 - a. Minimum application temperature 40°F.
 - b. Do not thin with solvents.
 - c. Use oven-dried aggregate only.
 - d. Maximum epoxy mortar thickness is 12-in per lift.
 - e. Epoxy mortar is for interior use only.
 - f. Do not seal exterior slabs on grade.
 - g. Minimum age of concrete must be 21-28 days, depending on curing and drying conditions, for mortar to seal slabs.

- h. Porous substrates must be tested for moisture-vapor transmission prior to mortar or sealing slabs.
- i. Not for injection of cracks under hydrostatic pressure.
- j. Do not inject cracks greater than 3-in.

B. Resin Type B:

1. To bond fresh concrete to hardened concrete - Apply by brush, roller, broom, or spray. Place fresh concrete while compound is still tacky. If coating becomes glossy and loses tackiness, remove any surface contaminates then recoat with additional compound. When spraying, use the following or similar equipment: #18 Air-Atomized Spray Gun (#68 fluid nozzle, #68 PB air nozzle, #68-5661 2-gal pressure fluid tank).
2. To anchor bolts, dowels, and pins - Use neat. For efficient transfer of stress, the hole should be no greater in diameter than 3-in. larger than the bar, pin, or rod to be embedded. Depth of embedment is typically 10 to 15 bar diameters.
3. To grout base plates - Add up to 12 parts of oven-dried aggregate to 1 part of mixed compound, by volume. Place grout under base plate. Avoid contact with the underside of the plate. A 1/4 to 3/8-in. space should remain between the top of the grout and the bottom of the plate. Maximum thickness of grout per lift is 12-in. If multiple lifts are needed, allow preceding layer to cool to touch before applying additional layer. The remaining 1/4 to 3/8-in. space should be filled with neat compound. Pour a sufficient quantity of neat epoxy to allow the level to rise slightly higher than the underside of the bearing plate.
4. To gravity feed cracks - Pour neat material into vee-notched crack. Continue placement until completely filled. Seal underside of slab prior to filling if cracks reflect through.
5. Limitations:
 - a. Minimum application temperature 40°F.
 - b. For spray applications, consult manufacturer.
 - c. Use only oven-dried aggregate.
 - d. Material is a vapor barrier after cure.
 - e. For applications on exterior, on-grade substrates, consult manufacturer.

C. Resin Type C:

1. As a structural adhesive - Apply the neat mixed compound to the mating or non-mating prepared substrates. Work into the substrate for positive adhesion. Secure the bonded unit firmly into place until the adhesion has cured. Glue line should not exceed 1/8-in.
2. To seal cracks for injection grouting - Place the neat mixed material over the cracks to be pressure injected and around each injection port. Allow sufficient time to set before pressure injecting.

3. To anchor bolts, dowels, and pins - Annular space around bolt should not exceed 1/8-in.; depth of embedments is typically 10-15 times the bolt diameter. Grout with neat compound.
4. For interior vertical and overhead patching - Place the prepared mortar in void, working the material into the prepared substrate, filling the cavity. Strike off level. Lifts should not exceed 12-in.
5. Limitations:
 - a. Minimum surface temperature 40°F.
 - b. Do not thin. Solvents will prevent proper cure.
 - c. Use oven-dried aggregate only.
 - d. Maximum epoxy mortar thickness is 12-in. per lift.
 - e. Epoxy mortar is for interior use only.
 - f. Material is a vapor barrier after cure.
 - g. Minimum age of concrete must be 21-28 days, depending upon curing and drying conditions, for mortar applications.
 - h. Porous substrates must be tested for moisture-vapor transmission prior to mortar applications.
 - i. Not for sealing cracks under hydrostatic pressure.

D. Resin Type D:

1. Epoxy Mortar - Prime prepared surface with mixed compound. Apply epoxy mortar by trowel or vibrating screed before primer becomes tack-free. Finish with Finishing trowel.
2. Epoxy Concrete - Consult manufacturer's instructions for placement and finishing of epoxy concrete.
3. Limitations:
 - a. Minimum surface temperature 40°F.
 - b. Test porous substrates for moisture-vapor transmission prior to any application.
 - c. Minimum age of concrete before application is 21-28 days depending upon curing, drying conditions.
 - d. Do not apply to exterior slab on grade.
 - e. Maximum application thickness on exterior substrates exposed to thermal changes is 2-in.
 - f. Do not dilute. Solvents will prevent proper cure.
 - g. Use oven-dried aggregates only.
 - h. Material is a vapor barrier after cure.

E. Resin Type E:

1. Broadcast Overlay - Prime the prepared substrate with compound. While primer is still tacky, spread mixed compound with a 3/16-in. notched squeegee.
 - a. When material levels, broadcast the oven-dried aggregate slowly allowing it to settle in the epoxy binder. Ultimately the broadcast aggregate should be applied to excess at a rate of 2 lb/sq ft.

- b. Remove excess broadcast aggregate after epoxy has set.
- 2. Epoxy Mortar - Prime prepared substrate with mixed compound. Before primer becomes tack-free, apply epoxy mortar by trowel or vibrating screed. Finish with finishing trowel.
- 3. Epoxy Concrete - Consult manufacturer's instructions for placement and finishing of epoxy concrete.
- 4. Limitations:
 - a. Minimum surface temperature 40°F.
 - b. Porous substrates must be tested for moisture-vapor transmission prior to any application.
 - c. Minimum age of concrete before application is 21-28 days depending upon curing and drying conditions.
 - d. Do not use on exterior slab on grade.
 - e. Maximum thickness 2-in. exterior exposed to thermal change.
 - f. Do not dilute. Solvents will prevent proper cure.
 - g. Use oven-dried aggregate only.
 - h. Material is a vapor barrier after cure.

F. Resin Type F:

- 1. Apply the compound mortar using a trowel. Work material into surface. Fill void from deepest to shallowest area. Strike off level.
- 2. Limitations:
 - a. Do not thin. Solvents will prevent proper cure.
 - b. Use only oven-dried aggregate.
 - c. Minimum application temperature 40°F.
 - d. Porous substrates must be tested for moisture-vapor transmission prior to application.
 - e. Material is a vapor barrier after cure.
 - f. Minimum age of concrete before application is 21-28 days, depending on curing and drying conditions.
 - g. Thickness in excess of 2-in. is not recommended in areas exposed to thermal change.
 - h. Maximum thickness of 12-in./lift for interior applications.

G. Resin Type G:

- 1. As a structural adhesive - Apply the neat mixed compound to the prepared substrates. Work into the substrate for positive adhesion. Secure the bonded unit firmly into place until the adhesive has cured. Glue line should be kept as thin as possible, not to exceed 3-in.
- 2. To seal injection ports and cracks for injection grouting - Place the neat mixed material over the cracks to be pressure-injected and around each injection port. Allow sufficient time to set before pressure-injecting.
- 3. To anchor bolts, dowels, pins - Annular space around bolt should not exceed 1/8-in.; depth of embedment is typically 15 times the bolt diameter. Grout with neat compound.

4. To grout cracks - Use automated injecting equipment or manual method. Set appropriate injection ports based on the system used. Cracks up to 3-in. wide may be grouted.
5. To seal base plates and bearing pads - Inject in-place base plate or bearing pads with compound up to 3-in. thick. Consult manufacturer's instructions for additional information.
6. Limitations:
 - a. Minimum surface temperature 40°F.
 - b. Do not thin. Solvents will prevent proper cure.
 - c. Material is a vapor barrier after cure.
 - d. Not for sealing cracks under hydrostatic pressure.

PART 4 - MEASUREMENT AND PAYMENTS

0.1 GENERAL

- A. No separate measurement or payment will be made for work required under this Section. All costs in connection therewith shall be considered incidental to the item or items of work to which the epoxy compound pertains.

END OF SECTION

NOTES TO THE DESIGNER

- A.** Any request to modify or waive the specification requirements listed below must be approved in writing by the MBTA's Director of Design:

1. None.